What is claimed is,

[1] A treatment process of a solution containing an organic compound having a fluorocarbon chain (hereinafter said to as the fluorine compound) and a polymer containing fluorine, the process comprising,

adding divalent and trivalent metal salts to said solution,

forming a layered double hydroxide having the fluorine compound between layers to fix the fluorine compound, and

precipitating said layered double hydroxide with the polymer containing fluorine.

[2] A treatment process of a solution containing the fluorine compound and a polymer containing fluorine, the process comprising,

adding divalent and trivalent metal salts to said solution,

forming a layered double hydroxide having the fluorine compound between layers to fix the fluorine compound,

precipitating said layered double hydroxide having the fluorine compound between layers and the polymer containing fluorine,

recovering a solid part by a solid-liquid separation,

dissolving said recovered solid part in an acid, and

separating a fluorine compound or its salt.

[3] The treatment process of the solution containing the fluorine compound and the polymer containing fluorine according to claim [1] or [2], the process further comprising,

adjusting pH of the solution to more than 4,

precipitating the layered double hydroxide having the fluorine compound between layers and the polymer containing fluorine compound.

[4] The treatment process of the solution containing the fluorine compound and the polymer containing fluorine according to claim [1] or [2], the process further comprising,

adding an alkali to the solution to adjust pH from 4 to 12,

adding divalent and trivalent metal salts to said solution, and

precipitating the layered double hydroxide having the fluorine compound between layers and the polymer containing fluorine.

[5] The treatment process of the solution containing the fluorine compound and the polymer containing fluorine according to any one of claims [1] to [4],

wherein the divalent metal salt is a salt of magnesium, calcium, zinc, nickel, copper, manganese (divalent), or cobalt (divalent), and the trivalent metal salt is a salt of aluminum, iron, chromium, manganese (trivalent), cobalt (trivalent), potassium, lanthanum, or scandium.

[6] The treatment process of the solution containing the fluorine compound and the polymer containing fluorine according to any one of claims [1] to [5],

wherein the divalent and the trivalent metal salts are chlorides.

[7] The treatment process of the solution containing the fluorine compound and the polymer containing fluorine according to any one of claims [1] to [6],

wherein said fluorine compound is carboxylic acid or sulfonic acid having the fluorocarbon chain, in which the number of carbon is more than 5.

[8] The treatment process of the solution containing the fluorine compound and the polymer containing fluorine according to any one of

claims [1] to [7],

wherein the polymer containing fluorine is poly-tetra-fluoro-ethylene.

[9] The treatment process of the solution containing the fluorine compound and the polymer containing fluorine according to any one of claims [1] to [8],

wherein the layered double hydroxide having the fluorine compound between layers is shown in the following formula [1].

$$M(II)_{1-x}M(III)_x(OH)_2Y_{X/m}\cdot nH_2O \quad \cdots\cdots[1]$$

where Y is an anion having valence number m of the fluorine compound having the fluorocarbon chain, M(II) is a divalent metal ion, M(III) is a trivalent metal ion, X is 0.1 to 0.5, and n is 0 or positive integer.

[10] A treatment process for recovering the fluorine compound and its salts, the process comprising,

precipitating the layered double hydroxide and the polymer containing fluorine by the treatment process according to any one of claims [1] to [9],

recovering the solid part by the solid-liquid separation,

dissolving said recovered solid part in a mineral acid to recover the separated fluorine compound or its salts, or

heating said mineral acid dissolving the recovered solid part,

putting quietly to separate an oil layer, and

taking out an oil layer to recover the fluorine compound and its salts.

[11] A treatment process for recovering the fluorine compound and its salts, the process comprising,

precipitating the layered double hydroxide and the polymer containing fluorine by the treatment process according to any one of claims [1] to [9],

recovering the solid art by the solid-liquid separation,

contacting said separated solid part with a sodium carbonate aqueous solution,

recovering the solid part by the solid-liquid separation,

dispersing the recovered solid part to an organic solvent ,and

filtering an insoluble solid part from said solvent.

add A2

Summary

Divalent and trivalent metal salts are added to the solution containing the fluorine compound and the polymer containing fluorine to precipitate the layered double hydroxide containing the fluorine compound between layers. At this time, the polymer containing fluorine suspended in the solution is also coagulated to precipitate. By these processes, the fluorine compound is fixed with high rate to separate from the solution with the polymer containing fluorine, and recovered if necessary. By this treatment process, the fluorine compound and the polymer containing fluorine, contained in the wastewater etc. can be separated easily, and the burden to environment or ecosystem can be reduced.

Table 1

No.	Fluorine Compound in solution: Kinds	Fluorine Compound in solution: Concentration	Polymer Containing Fluorine in solution	Additional Metal Salts mmol: Trivalent	Additional Metal Salts mmol: Divalent	pH Adjustment	Precipitate Weight (g)	Fixing Ratio of Anion %	Precipitation Rate of Polymer %	Concentration in Supernatant liquor: Anion	Concentration in Supernatant liquor: Polymer
1	Per-fluoro-octanoic acid ammonium ($C_7F_{15}COONH_4$)	148ppm 1 L	PTFE 2300ppm	Al 0.378 (1.1)	Zn 0.755 (2.2)	6.5～7.5	2.50	98.6	98%	2ppm	<50ppm
2	Ditto	200ppm 1 L	PTFE 2300ppm	Al 0.603 (1.3)	Mg 1.21 (2.6)	9～10	2.54	95.9	98%	8ppm	<50ppm
3	Ditto	148ppm 1 L	PTFE 2300ppm	Al 4.46 (1.3)	Mg 8.92 (2.6)	10～11	3.56	98.6	98%	2ppm	<50ppm
4	Ditto	500ppm 20 L	PTFE 2300ppm	Al 30.2 (1.3)	Zn 69.6 (3.0)	6.5～7.5	65.2	99.4	98%	3ppm	<50ppm
5	Ditto	500ppm 20 L	PTFE 2300ppm	Al 46.4 (2.0)	Mg 92.8 (4.0)	9～10	66.6	99.4	98%	3ppm	<50ppm
6	Same conditions of precipitate formation as No.4, Recovered precipitate is dissolved in concentrated hydrochloric acid to recover per-fluoro-octanoic acid										
7	Same conditions of precipitate formation as No.5, Recovered precipitate is dissolved in dilute sulfuric acid to take out an oil layer of per-fluoro-octanoic acid without filtering undissolved										
8	Ditto	1000ppm 1 L	PTFE 2300ppm	Al 2.32 (1.0)	Ca 4.64 (2.0)	9～10	3.22	65.6	98%	344ppm	<50ppm
9	Per-fluoro-decanoic acid ammonium ($C_9F_{19}COONH_4$)	500ppm 1 L	PTFE 2300ppm	Al 1.88 (2.0)	Mg 3.77 (4.0)	9～10	2.82	99.4	98%	3ppm	<50ppm
10	Per-fluoro-octanoic acid ammonium (Liquid Temperature 50-60℃)	148ppm 1 L	PTFE 2300ppm	Al 0.378 (1.1)	Zn 0.755 (2.2)	6.5～7.5	2.62	91.2	98%	13ppm	<50ppm
11	Per-fluoro-octanoic acid ammonium ($C_7F_{15}COONH_4$)	100ppm 1 L	PTFE 2300ppm	Al 0.232	Zn:0.232 Mg:0.232	8～9	2.32	96.0	98%	4ppm	<50ppm

(Note) The value of ( ) of metal salt concentration is mole ratio. The precipitate weight is a dried weight (g). The fixing ratio of anions is (%) to the initial concentration of a fluorine compound. The precipitation rate of polymer is a precipitated weight (%) to the initial concentration of a polymer containing fluorine. An anion in the supernatant liquor is a fluorine compound. The liquid temperature excepting No. 10 is 26℃.